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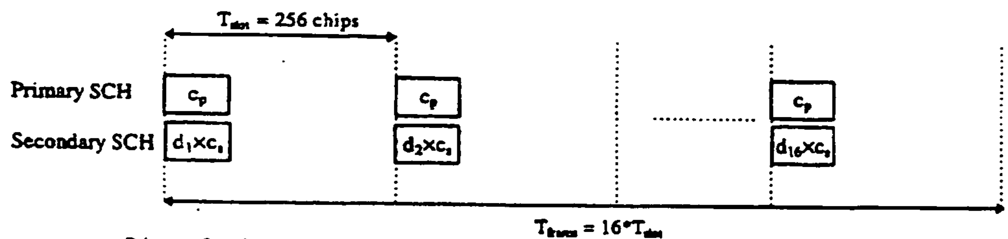
2.6.4 Initial cell search

During the initial cell search, the mobile station searches for the base station to which it has the lowest path loss. It then determines the downlink scrambling code and frame synchronisation of that base station. The initial cell search uses the synchronization channel (SCH) described in Section 2.4.2.3, the structure of which is repeated in Figure 23 below.



c_p: Primary Synchronization Code
c_s: Secondary Synchronization Code (one of 16 codes)
$d_1, d_2, \ldots, d_{16}$: Secondary SCH modulation

Figure 23 Structure of synchronization channel (SCH)

This initial cell search is carried out in three steps:

2.6.4.1 Step 1: Slot synchronisation

During the first step of the initial cell search procedure the mobile station uses the primary SCH to acquire slot synchronisation to the strongest base station. This is done with a single matched filter (or any similar device) matched to the primary synchronisation code c_p which is common to all base stations. The output of the matched filter will have peaks for each ray of each base station within range of the mobile station, see Figure 24. Detecting the position of the strongest peak gives the timing of the strongest base station modulo the slot length. For better reliability, the matched-filter output should be non-coherently accumulated over a number of slots.

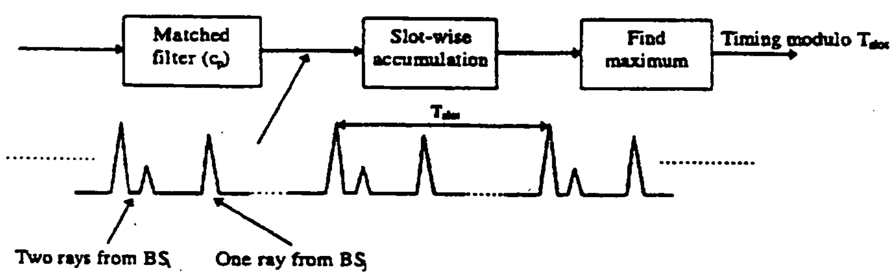


Figure 24 Matched-filter search for primary synchronization code to slot synchronization (timing modulo the slot length)

2.6.4.2 Step 2: Frame synchronisation and code-group identification

During the second step of the initial cell search procedure, the mobile station uses the secondary SCH to find frame synchronisation and identify the code group of the base station found in the first step. This is done by correlating the received signal at the positions of the Secondary Synchronisation Code with all possible (16) Secondary Synchronisation Codes. Note that the position of the Secondary Synchronisation Code is known after the first step, due to the known time offset between the Primary and the Secondary Synchronisation Codes. Furthermore, the unmodulated primary SCH can be used as a phase reference in the demodulation of the modulated SCH.

The correlation with the 16 different Secondary Synchronization Codes gives 16 different demodulated sequences. To achieve frame synchronization, the 16 demodulated sequences should be correlated with the 16 different cyclic shifts of the Secondary SCH modulation sequence $\{d_1, d_2, \ldots, d_{16}\}$, giving a total

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of 256 different correlation values. By identifying the code/shift pair that gives the maximum correlation value, the code group as well as the frame synchronization is determined.

2.6.4.3 Step 3: Scrambling-code identification

During the third and last step of the initial cell-search procedure, the mobile station determines the exact scrambling code used by the found base station. The scrambling code is identified through symbol-by-symbol correlation over the Primary CCPCH with all scrambling codes within the code group identified in the second step. Note that, from step 2, the frame boundary and consequently the start of the scrambling code is known. Correlation must be carried out symbol-wise, due to the unknow modulation of the primary CCPCH.

After the scrambling code has been identified, the Primary CCPCH can be detected, super-frame synchronisation can be acquired and the system- and cell specific BCCH information can be read.

2.6.5 Handover

2.6.5.1 Intra-frequency handover

2.6.5.1.1 Soft handover

When in active mode, the mobile station continuously searches for new base stations on the current carrier frequency. This cell search is carried out in basically the same way as the initial cell search described in Section 2.6.4. The main difference compared to the initial cell search is that an active mobile station has received a priority list from the network. This priority list describes in which order the downlink scrambling codes should be searched for and does thus significantly reduce the time and effort needed for the scrambling-code search (step 3) described in Section 2.6.4.3. Also the second step may be reduced if the priority list does only include scrambling codes belonging to a subset of the total set of code groups. The priority list is continuously updated to reflect the changing neighbourhood of a moving mobile station.

During the search, the mobile station monitors the received signal level broadcasted from neighbouring base stations, compares them to a set of thresholds, and reports them accordingly back to the base station. Based on this information the network orders the mobile station to add or remove base station links from its *active set*. The *active set* is defined as the set of base station from which the same user information is sent, simultaneously demodulated and coherently combined, i.e. the set of mobile terminals involved in the soft handover.

An example algorithm for reporting signal level and optimising the active set can be found in Tdoc SMG2 UMTS A16/97.

From the cell-search procedure, the mobile station knows the frame offset of the CCPCH of potential soft-handover candidates relative to that of the source base station(s) (the base stations currently within the active set). When a soft handover is to take place, this offset together with the frame offset between the DPDCH/DPCCH and the Primary CCPCH of the source base station, is used to calculate the required frame offset between the DPDCH/DPCCH and the Primary CCPCH of the destination base station (the base station to be added to the active set). This offset is chosen so that the frame offset between the DPDCH/DPCCH of the source and destination base stations at the mobile-station receiver is minimised. Note that the offset between the DPDCH/DPCCH and Primary CCPCH can only be adjusted in steps of one DPDCH/DPCCH symbol in order to preserve downlink orthogonality.

2.6.5.1.2 Softer handover

Softer handover is the special case of a soft handover between sectors/cells belonging to the same base station site. Conceptually, a softer handover is initiated and executed in the same way as an ordinary soft handover. The main differences are on the implementation level within the network. For softer handover, it is e.g. more feasible to do uplink maximum-ratio combining instead of selection combining as the combining is done on the BTS level rather than on the BSC level.

2.6.5.2 Inter-frequency handover

In WCDMA the vast majority of handovers are within one carrier frequency, i.e. intra-frequency handover. Inter-frequency handover may typically occur in the following situations: